

## **DIVISION 16**

### **ELECTRICAL**

#### **GENERAL**

This specification globally outlines the specifications of the proposed electrical equipment and materials being the basis of the power primary distribution and supply network.

#### **SECTION 16060 “GROUNDING AND BONDING”**

##### **1. GENERAL**

This document is an outline specification for the earthing installation and is for use as a guide in the design of the installation. It considers the earthing, bonding of electrical and project equipment.

The systems and methods described herein may be adopted or modified to meet local regulations or local practices and materials. The Earthing System will be designed in accordance to IEC 60364, BS7430, and other relevant Local and International Standards to ensure the following:

- A predetermined path for earth fault currents
- Efficient rapid operation of protective devices in case of earth faults
- The current carrying capacity of the system is sufficient to deal with maximum anticipated earth fault currents.
- The lowest practicable voltage appears (under fault conditions) between earthed points of apparatus and the mass of the earth so that insulation breakdown, dangerous voltages or overheating do not occur.

Facilities should be provided for maintenance, inspection and testing of the earthing installation.

All earthing systems must be intentionally bonded together to make a single point connection to earth.

##### **2. ELECTRICAL EQUIPMENT EARTHING**

###### **2.1 PROTECTIVE CONDUCTORS**

The metal enclosures of all switchgear and equipment in the Power Distribution System shall be connected to earth by means of protective conductors. For three-phase and Neutral Systems a dedicated, separate earth cable may be run. For Medium Voltage Systems, the cable tape/wires armored shall be utilized as the dedicated earth return path.

## **2.2 EQUIPOTENTIAL BONDING**

All extraneous metal work accessible shall be bonded and connected to earth to minimize the chances of danger owing to earth fault and leakage currents. Where this does not occur naturally (i.e. where all metallic items of equipment are adequately bolted to a metallic structure) it will be established by fitting bonding conductors between items, which are otherwise insulated from each other.

## **2.3 SOCKET OUTLET CIRCUITS**

All main socket outlet circuits and those intended for use with welding outlets, portable hand tools and other situations shall be connected to the Earthing System.

## **2.4 EARTH ELECTRODE SYSTEMS**

The resistance to earth of the Electrode System shall not exceed 5 Ohms for power network and 1 Ohm for clean earth. If overall resistance to earth of the network is greater than the specified value, additional copper earth rods shall be driven into the ground at a spacing of not less than twice-rod length apart.

3 meter copper clad steel earth electrodes at intervals according to the drawings around the buildings shall be interconnected with a bare copper cable not less than (95 mm sq) directly buried in the ground at a depth of 750 mm and extend 1 m away from the foundation. All earth bars shall be connected in a continuous ring with cable sizes as calculated by IEC and local standards, for the relevant prospective short circuit and associated protective device clearance time.

All internal and exterior steel columns shall have foundation earth using the column footer anchor bolts and rebar connected to the earth rod. All connection shall be exothermic welded.

Means of disconnecting individual electrodes or groups of electrodes for testing shall be provided. This may be at the point where rods emerge from the ground or at the substation main earth busbar for those electrodes connected to it.

BS 7430 gives detailed guidance on earth electrodes and soil resistivity.

**Earth Terminal Busbar:** An earth terminal or busbar shall be provided for every installation.

At substations the following equipment shall be connected directly to the main earth busbar:

- The earth bar of each switchboard/MCC. For each LV Switchboard this will facilitate the connection between the transformer secondary winding 'neutral' and earth. The transformer neutral point is brought into the

switchboard and connected to the neutral busbar, which is connected to the earth bar by means of a removable link.

- Field mounted LV equipment shall be earthed via the feeder cable armour or by using a separate earth conductor within the supply cable. Cable glands with cast integral earth lugs may be provided to ensure a good quality earth continuity connection.
- Control rooms will be equipped with their own earth bars (clean) for local bonding of equipment. These earth bars shall be connected to the main earth busbar. The equipment situated within these rooms shall be earthed, primarily, through the earth conductors of their feeder cables.

## **SECTION 16120 “WIRES AND CABLES”**

All neutral conductors shall be of an equal rating to the respective phase conductors.

Over sheaths shall be low smoke flame retardant.

The power cables shall be sized to limit the voltage drop between transformer and the loads to less than 5%.

Cable specifications shall meet IEC standards.

### **1. LOW VOLTAGE CABLES**

- |                            |   |
|----------------------------|---|
| - Routing Location         | Outdoors / Indoors  |
| - Ambient Temp. & Humidity | - Max. 45° C<br>- Min. 0° C<br>- Average 35° C<br>- Humidity (Max.) 90%             |
| - Standards                | - BS 5467<br>- IEC 60 502   |
| - Voltage Grade            | 600/1000 Volt   |
| - Number of Conductors     | 1, 2, 3 or 4  |
| - Conductor Size           | 6 mm <sup>2</sup> (min.)  |
| - Conductor Material       | Stranded copper   |
| - Insulation Type          | PVC   |
| - Laying Up                | Multi-core cables laid up with suitable fillers to form a compact circular assembly |
| - Bedding                  | Extruded PVC separation level   |
| - Over sheath              | PVC extruded layer – Color Black - LSF  |
| - Phase Identification     | Red/Yellow/Blue/Black for multicore   |
| - Testing                  | Routine tests with certificates   |

## 2. LOW VOLTAGE WIRES

Routing Location	Indoors
Ambiant Temp. & Humidity	- Max. 45° C - Min. 0° C - Average 35° C - Humidity (Max.) 90%
Standards	- BS 5467 - IEC 60 502
Voltage Grade	450/750 Volt
Number of Conductors	Single conductor
Conductor Size	3 mm <sup>2</sup> (min.)
Conductor Material	Stranded copper
Insulation Type	PVC
Phase Identification	Red/Yellow/ Blue/Black as required/Green or yellow green for earthing
Testing	Routine tests with certificates

## SECTION 16124 “MEDIUM VOLTAGE CABLES”

- Routing Location	Outdoors/Indoors
- Ambient Temp. & Humidity	- Max. 45° C - Min. 0° C - Average 35° C - Humidity (Max.) 90%
- Standards	- BS 6622 - IEC 60 502
- Voltage Grade	18/30 kV
- Number of Conductors	1 or 3
- Conductor Size	As specified in the drawings
- Conductor Material	Copper - Stranded
- Conductor Screening	Extruded semi-conducting compound
- Insulation Type	Cross linked polyethylene (XLPE)
- Core Screening	Combination semi-conducting metallic layer
- Laying Up	Multi-core cables laid up with suitable fillers to form a compact circular assembly
- Bedding	Extruded separation level
- Over sheath	PVC extruded layer –Black or Red Color
- Phase Identification	Red/Yellow/Blue
- Testing	Routine tests with certificates

## SECTION 16130 “RACEWAYS AND BOXES”

### 1. INTERIOR RACEWAYS

lighting and small power systems shall be installed in heavy gauge galvanized screwed conduit or galvanised trunking.

## **2. EXTERIOR RACEWAYS**

For lighting and small power systems installed external to buildings, conduit systems shall be heavy gauge galvanised screwed steel.

Minimum size of conduits for exterior installation shall be 1" diameter.

For all systems appropriate proprietary accessories, i.e. bends and boxes etc. shall be used.

## **3. Manholes/Handholes**

Manholes/hand holes shall be of the cast-in-place type. Straight runs between manholes shall be according to the drawings. Shorter distances will be used when change in direction is required.

## **SECTION 16139 "CABLE LADDERS AND TRAYS"**

Main power distribution cables shall be laid on adequately sized cable ladders, cables from SMSBs and DBs to the load shall be located on cable trays. Cable ladders and trays shall be of post hot-dip and painted galvanized steel.

All accessories including bends, tees, etc. shall be purpose made by the ladder or tray manufacturers.

Cables shall be placed on the ladders and trays as a single layer.

Connection to equipment shall be via cable glands. Outside cable trays shall be covered.

Cable ladders and cable trays shall provide min 20% spare space.

Power cable ladders or trays shall support point load of one person (90 kg) at the middle without deforming the tray.

All accessories including bends, tees etc. shall be purpose made by the ladder or tray manufacturers.

## **SECTION 16140 "WIRING DEVICES"**

### **1. ISOLATOR**

Suitable types of local fused switches or isolators are provided adjacent to process machines, electric appliances, and loads related to mechanical or HVAC systems such as water heaters, water coolers, hand dryers, air-handling units (AHU), Fan Coil Units (FCU)pumps, etc. to allow easy maintenance of such equipment.

### **2. CONVENIENCE SOCKET OUTLETS**

(2P + E), 16A earthed sockets are for general use.

Another particular type of waterproof, (2P + E), IP 54 earthed type shall be used in wet/damp areas, IP 67 for external areas.

General purpose power socket outlets and welding outlets shall be provided in all production, utility, maintenance and storage areas.

Offices shall have single phase sockets only.

Socket outlets conduits and boxes are totally segregated from any other system.

## SECTION 16231 “PACKAGED ENGINE GENERATORS”

Location	Indoors	
Ambient Temperature	Maximum	- 45°C
And Humidity	Minimum	- 0°C
	Average	- 35°C
	Humidity (Max.)	- 90%
Standards	BS 799	- Air filter for ICE
	IEC 60034	- Rotating electrical machines
	IEC 60073	- Indicator/pushbutton colors
	ISO 3046	- Reciprocating Internal Combustion Engines
Output Rating	Rating will be decided later, at 0.8 power factor, standby with 10% overload capacity	
Output Voltage	380/220 volts, 3 phase, 4 wire; +/-1.5% no load to full load at 0.8 pf under steady state conditions	
Output Frequency	50Hz, $\pm 10\%$ under steady state conditions	
Scope of Supply	Supply, install and test	
Operational Requirement	<p>Suitable for automatic operation after mains failure on receipt of an under voltage signal from the incoming supply to the switchboard</p> <p>Manual starting required for test purposes</p> <p>Set shall be ready to accept load in 10 seconds</p> <p>Set shall be capable of accepting the standing load and then accelerating the groups of load in timed sequence.</p> <p>Upon restoration of the mains supply for a predetermined time, the alternator will be disconnected from the switchboard after the switchboard had been automatically re-connected to the mains supply.</p> <p>No synchronization facilities will be required.</p>	
Diesel Engine	<ul style="list-style-type: none"> <li>- Rate to produce alternator output continuously and 110% of that rating for 60 minutes in any 12-hour period</li> <li>- Water cooled with sealed radiator cooled by engine mounted fan</li> <li>- Engine governor to meet limits of ISO 3046, Class A1</li> <li>- Engine mounted gauge panel</li> <li>- Starting by electric motor from battery (rated for 6 start cycles) charged from engine driven generator</li> </ul>	

Alternator	<ul style="list-style-type: none"> <li>- Noise level at exhaust shall not exceed 80 dBA at 1 meter</li> <li>- Rated to start and continuously supply loads which are predominantly DOL started and VSD motors</li> <li>- Self-excited, self-regulating, brushless, horizontal foot mounted, single bearing type connected to the engine via a solid flywheel</li> <li>- Enclosure protection to IP 22 min</li> <li>- Winding insulation shall be Class H, restricted to Class B temperature rise</li> </ul>
Generator Control Panel	<ul style="list-style-type: none"> <li>- Located on Set or free standing in same room as generating set</li> <li>- Enclosure protection to IP 54 min</li> <li>- Panel shall include, but not limited to: <ul style="list-style-type: none"> <li>- Incoming supply isolator</li> <li>- Aux. Isolators for all circuits</li> <li>- CT's main fuses and relays</li> <li>- Meters and indicators</li> <li>- Pushbutton controls</li> <li>- Information, alarm and fault indication lamps</li> <li>- Volt free contacts for remote indication of 5 main signal</li> </ul> </li> <li>- Routine load tests will be witnessed by the Client</li> </ul>
Inspection and Testing	<ul style="list-style-type: none"> <li>- Manufacturers of engine and alternator will submit their routine test certificates</li> <li>- Generator control panel tests</li> <li>- Combined set test, including: <ul style="list-style-type: none"> <li>-Full load for 2 hours</li> <li>-110% load for 30 minutes</li> <li>-Instantaneous load switching to simulate load acceptance capacity</li> <li>-Standard tests</li> </ul> </li> </ul>

## **SECTION 16264 “STATIC UNINTERRUPTIBLE POWER SUPPLY” (UPS)**

Shall consist of Modular Power Sub-Assemblies:

- Rectifier/Charger
- Maintenance free batteries sealed lead-acid (10 min back-up time)
- Three phases inverter
- Mechanical maintenance by-pass

Assembly shall be confirming to IEC Standards With The Following Parameters:

- Overall efficiency 90%
- Overload capacity 125 for 10 minutes
- Rated voltage 380 V  $\pm$  1% 3 ph + N, 50  $\pm$  0.5 Hz
- Input voltage 380 V  $\pm$  1% 3 ph, 50  $\pm$  5 Hz
- Soundproof enclosure (max. 60 dBa)

## **SECTION 16280 "POWER FACTOR CORRECTION CAPACITORS"**

Location	Indoors
Application	Power factor correction capacitors to be supplied within a free standing metal enclosure to be connected to An Electrical System for the purpose of improving the overall power factor of the system.
Ambient Temp. & Humidity	<ul style="list-style-type: none"><li>- Max. 45° C</li><li>- Min. 0° C</li><li>- Average 35°C</li><li>- Humidity (Max.) 90%</li></ul>
Rating	As indicated on the drawings
Rated Voltage	380 V (to be operated at 440V to 470V)
System Frequency	50 Hz
Standards/ Specifications	IEC 60 831
Enclosure	Separate, free standing enclosure arranged for front access only, IP 54 (minimum). Cables enter from above via gland plate.
Cooling	Natural air-cooled.
Capacitor	<ul style="list-style-type: none"><li>- Low loss type (typically 0.5 watts/kVAr)</li><li>- The relay shall have full stage indication on loss of supply.</li><li>- Auto-manual control provided by means of selector switch for each stage, including indication.</li></ul>
Contactor Utilisation Category	The contactors shall be to category AC-6b of IEC 60 947 or by special contactors, purpose built for the switching of capacitors.
Earthing	An earth termination shall be fitted within the enclosure. All non-current carrying metal work shall be bonded to this termination.
Protection	PFC Panel will be protected at supply switchboard with a MCCB.
Finish	The enclosure shall be painted to Vendor's standard.
Labeling	A main label shall be fixed in a prominent position on the enclosure giving the main information of the equipment, including, but not limited to: <ul style="list-style-type: none"><li>- Panel identification</li><li>- Main system parameters</li><li>- Manufacturer's name</li><li>- Isolation source</li></ul>
Testing	<ul style="list-style-type: none"><li>- Routine testing only may be witnessed by the Client's representative.</li><li>- Test certificates for identical units shall be made available</li></ul>

## **Section 16341 "Medium Voltage Switchgear"**

The switchgear shall be of the indoor metal clad type according to IEC 62271.

The minimum rating for the medium voltage switchgear assembly shall be as follows:

- 22 kV operating voltage
- 24 kV Maximum voltage



- 750 MVA-breaking capacity
- 25 kA for 1sec - permissible short time withstand current

The switchgear shall be consists of (but not limited to):

- 4 incoming cells, each one is complete with 22 kV SF6 motorized withdrawable circuit breaker with interlocked earthing switch.
- 1 bus coupler cell complete with 22 kV SF6 motorized withdrawable circuit breaker with interlocked earthing switches.
- 1 bus riser cell.
- 10 outgoing cells, each one shall be complete with 22 KV SF6 motorized withdrawable circuit breaker with interlocked earthing switch.

Accessories, digital power meter, relays, mimic diagram, earth fault indicator, etc.

### **SECTION 16343 "RING MAIN UNIT"**

The ring main unit enclosure shall be made of steel sheet and treated against rust and provided with priming, intermediate and finishing coats of a electrostatic painting powder from inside and outside. The enclosure degree of protection shall be at least (IP54).

The minimum rating for the ring main unit assembly shall be as follows:

- 22 kV operating voltage
- 24 kV Maximum voltage
- 750 MVA-breaking capacity
- 25 kA, for 1sec - permissible short time withstand current

The switchgear shall be consists of (but not limited to):

- 2 incoming SF6 load break switches, 630 A each
- 2 outgoing SF6 motorized withdrawable circuit breaker with interlocked earthing switch.
- Accessories, meters, relays, mimic diagram, earth fault indicator, etc.

### **SECTION 16415 "AUTOMATIC TRANSFER SWITCH"**

- A fully automatic switch (A.T.S) for automatic start up, automatic load transfer and automatic shutdown with auto-test on load.
- Attempt starting: 3 times (10 sec. crank, 10 sec. Reset)
- Start delay: adjustable – 2 sec
- Return timer: adjustable – 3 sec
- Run on timer: adjustable – 5 sec

## SECTION 16425 “LOW VOLTAGE SWITCHBOARDS”

### 1. MAIN LOW VOLTAGE SWITCHBOARD

Location	Indoors
Ambient Temp. & Humidity	- Max. 45° C - Min. 0° C - Average 35° C - Humidity (Max.) 90%
System Voltage	380 V, 3 Phase, 50 Hz, TP&N.
Fault Level	Varies as per calculation.
Standards/ Specifications	IEC 60 051 - indicating instruments. IEC 60 439 - switchgear assemblies. IEC 60 947 - circuit breakers.
IP Rating	IP54 for indoor surface mounting, IP67 for outdoors.
Cable Entry Construction	Incoming and outgoing cables from above Totally enclosed sheet steel enclosure (minimum thickness 1.5 mm) mounted on a 100 mm high metal plinth (minimum thickness 3 mm). Doors shall open to at least 100° and preferably 120°. Doors shall have key locks.
Future Extension	The switchboard shall be suitable for future extension at each end.
Access	From front.
Busbar Ratings	Rating as per transformer size. Neutral to be rated at the same size of the phase busbars.
Air Circuit Breakers	- Air Circuit Breakers (ACBs) - Rating(s) as per transformers size and drawings - Withdrawable type - Manual spring charging, electrical closing - Shunt trip and manual mechanical trip - Safety interlocks - Incoming connections arranged to accept metal enclosed or cast-resin insulated bus ducting (top entry)
Current Transformers	- Rated for “short time” ratings - Ratio, rating and accuracy to suit function, loads and duties - Current transformer (5A secondary) required on the incoming circuit to provide current signal to the remote power factor correction relay
Protection Relays	Incomer circuit: IDMT/Inst. O/C, E/F, REF
Metering and Indication (Incomer)	- Digital multifunction meter with LCD display for all major electrical parameters - volts, amps, kW, kVA, kVAr, pf. - “Voltage present” indication lights on incoming side of ACB - Indication lamps for ACB status i.e. for “ACB open”, “ACB closed” and “ACB fault”
Outgoing Supply Circuit	(Ratings as indicated with enquiry/requirements sheet) Outgoing supply circuits shall be by either air circuit breakers

	(ACB) with protection for ratings 1250A and above or moulded case circuit breakers (MCCB's) with protection for ratings 1000A and less
Earthing	An earth bar shall be provided in the switchboard for bonding of all metallic equipment. The earth bar shall be sized for earth fault for short time rating (half of the phase busbar size as a minimum) and run the entire length of the switchboard.
Finish	Corrosion protected.
Painting	The switchboard shall be painted to Vendor's standard.
Labeling	A main label shall be fixed in a prominent position on each board giving the main information of the switchboard, including, but not limited to: <ul style="list-style-type: none"> <li>- Switchboard identification</li> <li>- Main system parameters</li> <li>- Fault ratings</li> <li>- Manufacturer's name</li> <li>- Circuit breakers shall include a label covering all data</li> </ul>
Testing	Routine testing only witnessed by Client's representative. Type test certificates (issued by international testing authority) shall be made available covering busbar assemblies and circuit breakers.

## 2. DISTRIBUTION BOARDS AND FEEDER PILLARS

All distribution boards and feeder pillars shall be factory assembled and factory certified according to IEC standards. Enclosures shall be IP30 for indoor flush mounting, IP54 for indoor surface mounting and IP67 for outdoor, mechanical rooms, and wet areas installations.

Distribution boards shall be equipped with moulded case circuit breakers while branch circuit panel boards shall be equipped with miniature circuit breakers with min. 10 kA short circuit interruption capacity.

All distribution boards and feeder pillars shall be equipped with phase indicating lamps, door lock and circuit designation sheet covered with Plexiglas.

All panel boards shall be identified and tagged with warning signs.

### SECTION 16450 "ENCLOSED BUS ASSEMBLIES"

The enclosed bus assemblies shall be feeder type; designed and constructed for use on 380V three phases five conductors, with 100% neutral and earthing, 50 Hz system and having fault level of 100 kA for 1.0 second.

### SECTION 16461 "DISTRIBUTION TRANSFORMER - DRY TYPE"

Location	Indoors	
Ambient Temp	Maximum	- 45° C

	Minimum	- 0° C
	Average	- 35° C
	Humidity (Max.)	- 90%
Rating	2500 KVA	
Type	Dry type	
No Load Turns Ratio (Primary/Secondary)	22000/400 V, 3-Phase according to Electricity Dist. Company requirements	
Secondary Voltage at Rated Load	380 V at 0.9 power factor	
Insulation Test Voltage	24000 V	
System Frequency	50 Hz	
Primary Fault Level	750 MVA	
Standards/Specifications	IEC 60 076 IEC 60 726	
Cooling	Natural, ANAN	
Enclosure IP	IP 33	
Vector Group	Dyn11	
Losses	Standard (vendor to advise) but not exceeding Electricity Distribution Company maximum acceptable limit	
Windings	– Copper – Uniform, Insulation class F	
Terminations	24 kV terminations via land plate for 3 cores XLPE tape screened copper cables. 400 V terminations made via separate land plate or by means of metal enclosed bus ducting (to be advised during detail design)	
Accessories	– Off-circuit bolted links on the primary winding giving tapings of $\pm 2\frac{1}{2}\%$ – Protection relays, providing functions for alarm and trip – Lifting lugs for enclosure – Bi-directional flat rollers on transformer, which can be set in two positions at 90° to each other – Earthing terminal – Nameplate	
Testing	– Routine testing only which may be witnessed by the Client – Type test Certificates for identical units shall be made available	

## **SECTION 16500 “LIGHTING”**

### **1. GENERAL**

This document outlines the lighting installation for the project. The systems and methods described herein may be adapted or modified to meet local regulations or to meet local practices and materials.

The lighting installation shall provide an adequate standard of lighting throughout the project. This shall include all external lighting and internal, together with ancillary areas. In addition, it shall include parking areas adjacent to the buildings. The lighting shall be designed to provide adequate

illumination to enable all tasks to be performed safely and efficiently in the various locations and to enable persons to pass from one area to another in safety. The design shall be such as to minimize glare and to provide an even illumination. In work areas the lighting required is a “white” light with high color rendering index. In addition, the design shall take into account the possibility of an electricity supply failure and the effects on the lighting system and possible danger to personnel resulting there from. Generally, the lighting in any one area shall be provided by more than one circuit.

The external lighting shall be designed to minimize the visual impact of the project when viewed from outside the plant boundary.

## **2. INDOOR LIGHTING**

Fluorescent and compact fluorescent lighting are preferred for use in offices and technical areas and the like where good color rendering is desirable. Fluorescent fittings 4 x 18 W & 2 x 36W and Compact Fluorescent fittings 2 x 40 W & 2 x 26 W will be used in general to provide the most suitable lighting design, taking into account, installation and running costs. Other fittings may be used as appropriate.

For fixture mounting heights in excess of 5.5m to the bottom of the fixture, high bay pulse-start metal halide light fixtures should be used.

No lighting fixture should be installed over raw materials, finished or stationary products. Light fixtures are to be installed in the aisles only.

High bay luminaires shall be supported by purpose made bracket, which shall be fixed to the roof steelwork.

A safety chain of suitable type to support the weight of the luminaires shall be fixed to the luminaires and bracket.

All high bay type luminaires shall be with clear glass covers that provide IP54 protection.

All fittings shall be suitable for the areas in which they are installed, e.g. in areas having suspended ceilings then fittings shall be of the integral recessed type, in areas prone to moisture, corrosion resistant luminaires shall be installed.

Offices, mechanical /electrical rooms and small rooms shall be locally switched (office areas shall have two level switching). Lighting in other areas shall be controlled via Lighting Control Panel (LCP).

## **3. OUTDOOR LIGHTING**

The outdoor lighting will be provided on a site within the project boundary using Metal halide and/or HPS luminaires supported on galvanized steel poles, These poles must be placed in such a manor that that the lights illuminate a minimum of 6m inside the fence and a minimum of 15m outside the fence.

The outdoor lighting luminaries will be of a semi cut-off type to produce an average illumination level for safety dark conditions to enable walking personnel to be visible in silhouette to driven vehicles. The more populated areas at the main entrance and parking areas will be flood illuminated at a higher level for safety and security purposes.

The electrical supply for the outdoor lighting will be derived from 380 Volts, 3 phase and neutral, 50 Hz distribution boards located on site. These will provide over current circuit protection and contactor switching via a photocell and timer with manual override. The lighting columns will be fitted with an individual over current device to be discriminated with the main supply distribution board protection device. Each lighting circuit will be serviced by means of an armored cable, which will be installed below ground via direct burial supplemented by cable ducts beneath hard standings and roadways.

Weatherproof type (IP67) bulkhead luminaries shall be surface mounted on the exterior wall above the entrance door.

## **SECTION 16670 “LIGHTNING PROTECTION”**

Lightning Protection System is provided to protect the building fabric, and electric equipment from direct lightning strikes or from secondary strikes within the geographical vicinity. The lightning protection system shall be interconnected with the plant earthing system to ensure the safe dissipation to earth of the electrical energy, which arises from a lightning strike, and to maintain the earthing systems at the same potential.

The lightning protection system shall comply with International Standards or the equivalent local standard or regulation.

The principal components of the lightning protection system are as follows:

- Air terminations
- Down conductors
- Earth termination networks (e.g. connection to earth electrodes)
- Bonding to prevent side flashing
- Test joints and facilities